

**CLAIMS**

What is claimed is:

1. A process for the hydrogenation of a polymer comprising the steps of:
  - 5 providing a polymer solution of at least one polymer in at least one solvent;
  - metering hydrogen gas and an hydrogenation catalyst solution into the polymer solution to create a reaction mixture;
  - pressurizing and heating the reaction mixture such that the contents of the reaction mixture exist in the supercritical phase; and
  - 10 hydrogenating said at least one polymer while the contents of the reaction mixture are in the supercritical phase.
2. A process for the hydrogenation of a polymer comprising the steps of:
  - 15 determining the critical temperature and critical pressure for a mixture of hydrogen, at least one polymer, and at least one appropriate solvent for the at least one polymer;
  - providing a polymer solution of the at least one polymer in the at least one appropriate solvent;
  - 20 metering, the hydrogen gas and an hydrogenation catalyst solution into said polymer solution, to create a reaction mixture;
  - pressurizing and heating the reaction mixture to meet or exceed the determined critical pressure and determined critical temperature of said step of determining; and
  - 25 hydrogenating the at least one polymer at or above the determined critical pressure and determined critical temperature.
3. An apparatus for the hydrogenation of a polymer comprising:
  - 30 a tubular coil reactor installed in a pressure vessel that is partly filled with a heat sink fluid to cover at least a portion of said tubular coil reactor;
  - a pump metering polymer solution, hydrogen, and hydrogenation

- catalyst solution to said tubular coil reactor to provide a reaction mixture in said tubular coil reactor, said tubular coil reactor being maintained at a temperature and pressure sufficient to place the contents of said reaction mixture in the supercritical phase; and
- 5           a condenser communicating with said pressure vessel to receive vapor from the heat sink fluid and convert it back to heat sink fluid liquid, and return the heat sink fluid liquid back to said pressure vessel.
4. An apparatus for the hydrogenation of a polymer at or above a determined supercritical temperature and determined supercritical pressure comprising:
- 10           a source of a polymer solution;
- a source of hydrogen;
- a source of an hydrogenation catalyst solution;
- a tubular coil reactor installed in a pressure vessel that is partly filled with a heat sink fluid to cover at least a portion of said tubular coil reactor, wherein said heat sink fluid is heated to near the determined supercritical temperature, and its saturation pressure is established, in the pressure vessel, such that the vapor phase of said heat sink fluid present in said pressure vessel is in equilibrium with the liquid phase of said heat sink fluid;
- 15           a pump metering polymer solution, hydrogen, and hydrogenation catalyst solution, from their respective sources, to said tubular coil reactor, at or above the determined supercritical pressure; and
- 20           a condenser communicating with said pressure vessel to receive heat sink fluid vapor and convert it back to heat sink fluid liquid, and return the heat sink fluid liquid back to said pressure vessel.
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